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Civilian Radioactive Waste Management System
Management & Operating Contractor

Report on Assessment of Fee Adequacy Based on FY 1999 TSLCC Update

TDR-CRW-SE-000003 REV 01

December 1999

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CHANGE HISTORY

Revision Number	Interim Change Number	Effective Date	Description and Reason for Change
00	00	09/99	Initial Issue.
01	00	12/99	Incorporated DOE comments to Rev. 00. Editorial changes made to clarify text. Incorporated new cost data from 1999 TSLCC Update REV 01. Tables and figures modified for updated analysis from new cost data.

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ACRONYMS AND ABBREVIATIONS

Acronyms

CPI	Consumer Price Index
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
EDA	Enhanced Design Alternative
FY	Fiscal Year
HLW	High-Level Waste
IPWF	Immobilized Plutonium Waste Form
LADS	License Application Design Selection
NRC	U.S. Nuclear Regulatory Commission
NWF	Nuclear Waste Fund
NWPA	Nuclear Waste Policy Act
SNF	Spent Nuclear Fuel
TSLCC	Total System Life Cycle Cost
YOE	Year-of-Expenditure

Abbreviations

kWh	Kilowatt-hour
yr	year
M	Million

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1. INTRODUCTION AND EXECUTIVE SUMMARY

1.1 FEE ADEQUACY RECOMMENDATIONS

This analysis finds that the current 1.0 mill ($0.001) per kilowatt-hour (kWh) fee charged on generators of commercial spent nuclear fuel (SNF) is adequate, and recommends that the fee not be changed. This recommendation is based on examination and analysis of the revenue forecasts and estimated costs for the program's current approach to a waste management system (DOE 1998b), and on consideration of the uncertainties associated with economic assumptions, program revenues, program scope, and cost estimates.

The costs assumed for this analysis are based on the Civilian Radioactive Waste Management System (CRWMS) Total System Life Cycle Cost (TSLCC) (CRWMS M&O 1999b) estimate. The TSLCC is consistent with the License Application Design Selection (LADS) Report (CRWMS M&O 1999c), extended to address total waste management system costs for all wastes planned for geologic disposal in a repository. The 1999 TSLCC report estimated the costs for two cases that differed in the assumption of when closure and decommission activities would begin. Case 1 assumes closure and decommissioning begin 50 years after the start of emplacement, and Case 2 assumes closure and decommissioning begin 125 years after the start of emplacement.

Although the costs for Case 1 and Case 2 in the 1999 TSLCC report (CRWMS M&O 1999b) have increased by 17 percent and 29 percent compared with the 1998 TSLCC estimate, the Nuclear Waste Fund (NWF) is projected to have a positive balance at the end of waste emplacement activities for both cases. This result is based on current fee revenue projections, and independent projections of inflation and interest rates. Sufficient capital in the NWF at the end of the emplacement period is the equivalent of a sinking fund, which is a fund accumulated to pay off a public or corporate debt. Despite the increase in program costs, the 1.0 mill per kWh fee charged on generators of commercial SNF remains adequate, since the bulk of the system cost increase occurs at the end of the program life cycle during closure and decommissioning activities. The financial impact of the program cost increase results in a requirement for more capital at the end of emplacement. The current adequacy of the 1.0 mill per kWh fee charged on generators of SNF has also been enhanced by an increase in the forecast of real interest rates, which is due to a decrease in inflation.

A sinking fund at the end of emplacement will provide future decision-makers the flexibility to defer closure from 50 years after the start of emplacement to 125 years after the start of emplacement. A sinking fund in excess of the net present value of the future costs provides a margin of safety for uncertainties and changes in program scope, costs, revenues, and economic assumptions.

1.2 BACKGROUND

The purpose of this report is to present an analysis of the adequacy of the 1.0 mill per kWh fee being paid by the nuclear utilities for the permanent disposal of their SNF. In accordance with the Nuclear Waste Policy Act of 1982 (NWPA), the costs for disposal of commercial SNF in a geologic repository are to be funded by a fee levied on electricity generated and sold. The fee

provides for intergenerational equity; i.e., it ensures that the beneficiaries of nuclear power pay for the costs of disposal of the wastes. These fees are deposited in the NWF. The NWF is to be used for development and implementation of a radioactive waste management system in accordance with the NWPA, including a permanent geologic repository. Any fees received in excess of annual funding requirements are invested in U.S. Treasury obligations at prevailing rates. Management of the NWF (also referred to as "the Fund") is an important element of the program, considering that the Fund must cover the cost of activities that extend far beyond the operating life of current nuclear power plants. For SNF generated by nuclear reactors prior to enactment of the NWPA in 1982, utilities are required to pay a one-time fee equivalent to 1.0 mill per kWh.

The CRWMS also was given the responsibility to dispose of radioactive wastes managed by the U.S. Department of Energy (DOE), referred to as the Department. The Department is required to pay its fair share of costs for disposal of defense-related materials such as DOE SNF, which includes naval SNF, and high-level waste (HLW) generated by weapons production activities. HLW includes Immobilized Plutonium Waste Form (IPWF). Costs for disposal of government-managed nuclear materials are paid through the Defense Nuclear Waste Disposal appropriations. A methodology for allocating costs between government-managed nuclear materials and commercial wastes was developed by public rulemaking in the August 20, 1987, Federal Register Notice (52 FR 31508). This rulemaking provided a vehicle for computing each party's fair share of total costs.

This assessment assumes that the Department will pay its full share of past and future costs, and therefore addresses only the continuing adequacy of the 1.0 mill per kWh nuclear utility fee to fund the civilian cost share.

1.3 PROGRAM STATUS

In May 1999, the LADS Report (CRWMS M&O 1999c) recommended using Enhanced Design Alternative II (EDA II) as the basis for further design work at Yucca Mountain. Two TSLCC estimates were developed based on and consistent with the LADS EDA II design, expanded in scope to address total program costs, and extended to all wastes planned for geologic disposal. The 1999 TSLCC provides the cost basis for this assessment.

Significant changes have occurred in the program since the last Fee Adequacy Assessment was published (DOE 1998e) that was based on the 1998 TSLCC (DOE 1998a). The current cost estimates show increases due to these changes in the program scope. The bulk of the cost increases occur at the end of the program life cycle. If the cost increases were the only change since the 1998 Fee Adequacy Assessment, fee and investment income would still be adequate to meet program costs, but the margin of safety for uncertainties and changes in program scope, costs, revenues, and economic assumptions would be reduced.

Through fiscal year (FY) 1998, the program has spent $5.9 Billion in year-of-expenditure (YOE) dollars, excluding $135 Million in interest on utility overpayments. When escalated to 1999 dollars, the $5.9 Billion becomes $7.3 Billion. Of the $5.9 Billion in YOE dollars, $4.2 Billion was spent on the first repository, and $0.1 Billion on a second repository. Approximately $0.4 Billion was spent on plans for a proposed Monitored Retrievable Storage facility, engineering

development, transportation system development, waste acceptance, project integration, and spent fuel storage. Program support has cost $1.0 Billion, and consists of Quality Assurance, Human Resources and Administration, and Program Management and Integration, including all costs for Federal employees. Transfer appropriations for the U.S. Nuclear Regulatory Commission (NRC), Nuclear Waste Technical Review Board (NWTRB), and the Office of the Nuclear Waste Negotiator have cost $0.2 Billion. Program expenditures are expected to continue for 69 years through the assumed closure and decommissioning of the repository in 2069 for Case 1, and 144 years through 2144 for Case 2.

1.4 STATUS OF THE NUCLEAR WASTE FUND

The NWF investments, as of September 30, 1998, had a market value of $8.6 Billion. This balance results from fees and investment income. From FY 1983 to the end of FY 1998, ongoing fee payments accounted for $7.6 Billion in YOE dollars ($9.1 Billion in 1999 dollars) of utility contributions. Utilities have accrued, but not yet paid, $0.1 Billion in 1.0 mill per kWh fees by the end of the accounting period. Cumulative one-time fee payments accounted for $1.5 Billion in program revenues, with $0.9 Billion in principal still owed. Interest received from fees and returns on the NWF investments have contributed $3.7 Billion, with outstanding receivables of $1.5 Billion (DOE 1999), primarily from interest on one-time fees. Based on projections of nuclear power generation, using a no-new-orders scenario, the last fee revenue will be received in 2036, which is 33 years prior to the anticipated completion date for repository decommissioning in 2069 for Case 1 and 108 years prior for Case 2.

Defense Nuclear Waste Disposal appropriations through FY 1998 totaled $0.9 Billion. These appropriations are not deposited in the NWF, nor are they counted as disbursements from the NWF. An additional $1.2 Billion of principal and interest is due from the Department for the disposal cost share for DOE SNF and HLW that were incurred through FY 1998. This outstanding balance was calculated based on the 1998 TSLCC (DOE 1998a) estimate.

The NWF balance, investment income, and future Defense Nuclear Waste Disposal appropriations for the disposal of DOE SNF and HLW will cover program expenditures after the fee revenues have ended. Figures 1 and 2 show, for both Case 1 and Case 2, the percentage of revenue required by appropriations from the Department, annual fees, one-time fees with accrued interest from the utilities, and the interest earned by the NWF to fund the program. These sources of revenue, except for Defense Nuclear Waste Disposal appropriations, are factors used in assessing the adequacy of the fee.

1.5 FACTORS AFFECTING THE ADEQUACY OF THE FEE

There are several factors that could affect fee adequacy and result in a need for adjustments to the ongoing 1.0 mill per kWh fee. Changes in the cost basis are a primary determinant of fee adequacy. Fee revenue projections affect the income that covers program costs. Finally, economic assumptions affect program costs through cost escalation, and interest income through interest rates.

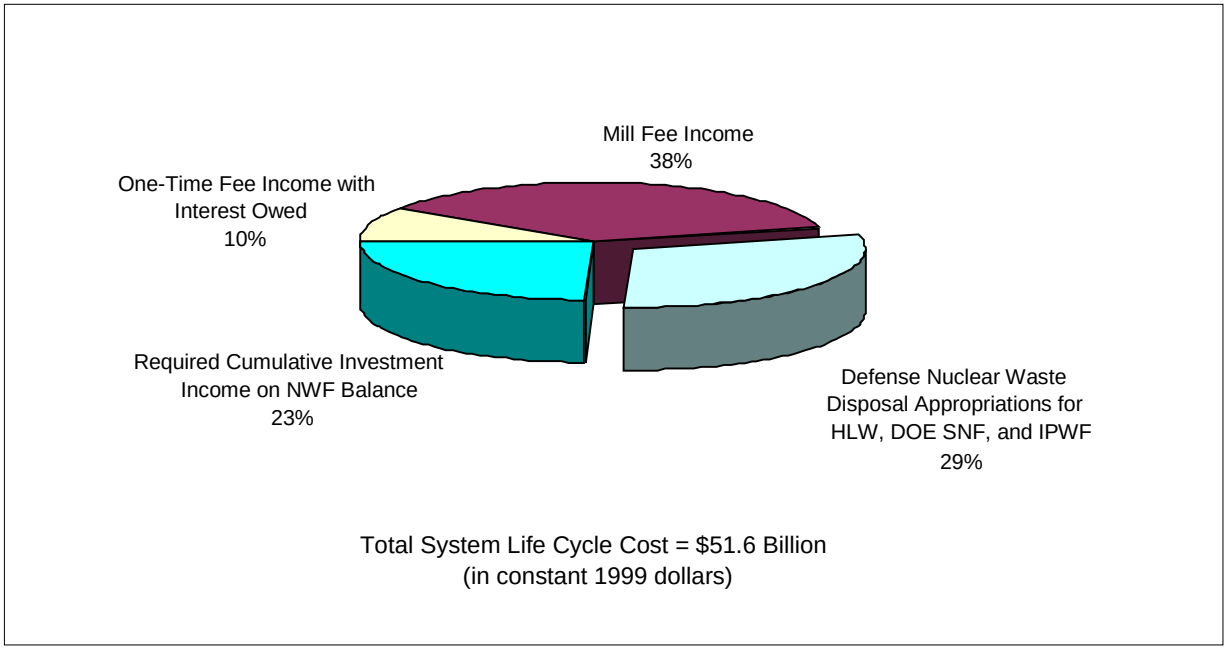

Figure 1. Revenue Sources Required to Fund Case 1 of the 1999 TSLCC (in Percentages of 1999$)

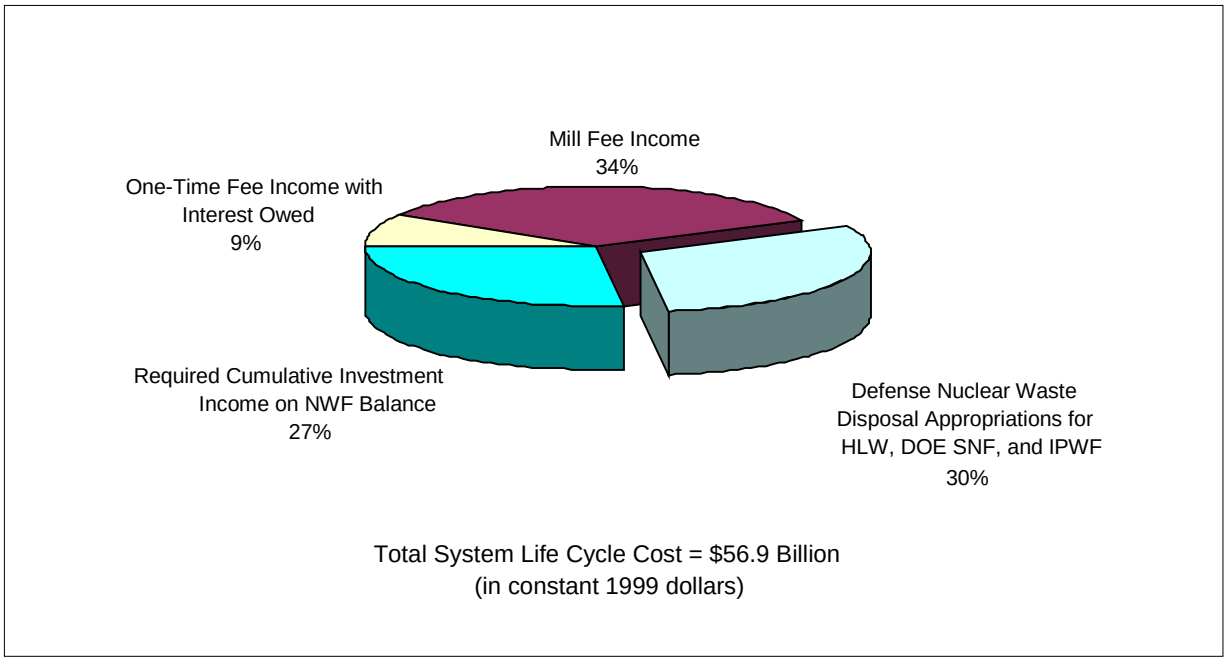

Figure 2. Revenue Sources Required to Fund Case 2 of the 1999 TSLCC (in Percentages of 1999$)

1.6 PROGRAM COST BASIS

The fee adequacy assessment is sensitive to changes in program costs. Program cost estimates may change as a result of estimating uncertainty and scope changes. Estimating uncertainty is addressed in the reference design cost estimate through the use of contingency factors applied to the estimate. However, there is additional uncertainty in cost due to possible future changes in program scope. These cost uncertainties are currently not quantified; they are addressed in Section 3.1.

The methodology used for determining the relative cost shares between civilian and government-managed nuclear materials is sensitive to program changes. The civilian share allocation decreased from the 1998 assessment (DOE 1998e). This is due to the incorporation of the EDA II that reduces the civilian share of disposal containers resulting from blending, and also reduces required emplacement drifting resulting from line-loading. Blending uses thermal management in the loading of waste packages that allows for more large waste packages to be used instead of small ones. This reduces the total number waste packages to be emplaced. Line-loading emplaces the waste packages closer to each other, creating a more uniform heat pattern along the drift wall than point-loading. Reduced separation between waste packages requires less emplacement excavation. Future program changes may again alter the share allocations.

1.6.1 Projected Fee Revenues

In the near term, fee revenue projections are known with a high degree of certainty based on projections by the DOE Energy Information Administration. Future projections based on reactor characteristics, known spent fuel discharges, and operating licenses also can be closely estimated. Uncertainty is introduced by the potential for early reactor shutdowns, before license expiration, or by service life extensions. Reductions or increases in electricity generation by nuclear power plants will impact both disposal costs and the amount of revenue paid into the NWF.

1.6.2 Economic Projections

As a result of the long duration of the program, economic factors such as interest and inflation rates, and near-term expenditure profiles have significant impact on the adequacy of the ongoing 1.0 mill per kWh fee. Unforeseeable periods of either low or high real interest rates would significantly decrease or increase the interest earned on the balance in the NWF. The opposite is true for inflation during the life cycle of the program. Increased inflation would cause higher costs, resulting in a lower NWF balance, thus resulting in less interest income. However, since inflation also directly affects the nominal interest rate, the effects of higher inflation on outlays may be partially offset by higher nominal interest earnings.

Figure 3 shows a comparison of the nominal and real interest rates on the 10-year U.S. Treasury note rate used in the 1998 fee adequacy analysis (DOE 1998e) and this analysis. The comparison between the 1998 and 1999 analyses in Figure 3 shows that the nominal rate forecast on the 10-year U.S. Treasury note rate has few and small differences, except for the forecast period 2022 through 2030. However, the real rate forecast on the 10-year U.S. Treasury note rate did change significantly over the whole forecast period, due to the lowering of the inflation

forecast. In general, the 1999 real interest forecast increased by a half-percent, with close to a full percent increase during the 2007 through 2016 period. The increase in the real rate on the 10-year U.S. Treasury note results in almost a doubling of the NWF balance in 2042.

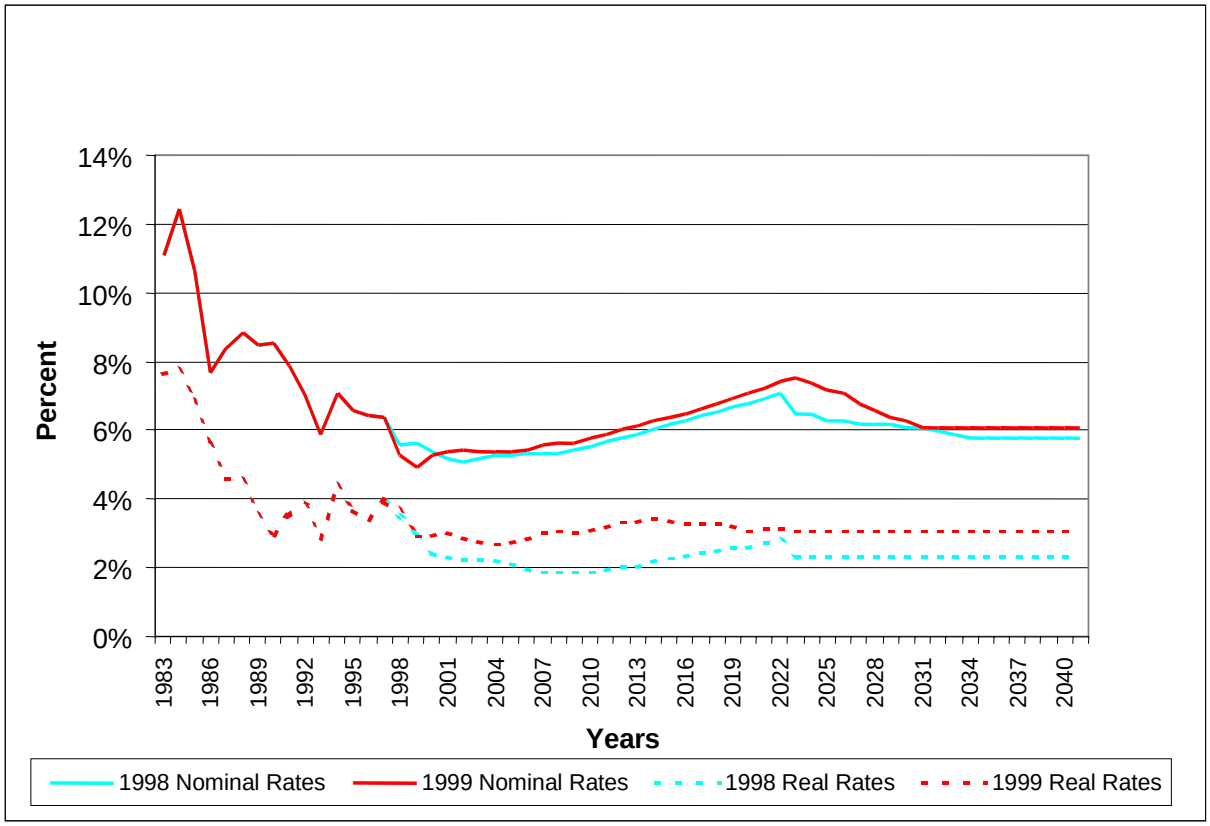

Figure 3. Comparison of 1998 and 1999 Nominal and Real Yields on the 10-Year U.S. Treasury Note

2. METHODOLOGY

This section describes the methodology used in this analysis, the key assumptions and the data that provide the basis for the assessment. The methods used for this analysis are the same as those employed in the 1998 fee adequacy assessment (DOE 1998e).

The evaluation of fee adequacy is based on the principle of full-cost recovery presented in Section 302 of the NWPA, under which all costs related to the waste disposal services will be paid for by the owners and generators of SNF and HLW. This principle of full-cost recovery underlies the basic analytical methodology used by the Department. The methodology for projecting the adequacy of the fee uses a forecasted revenue stream of fees paid into the NWF by the utilities, and compares it to the disbursement forecast to determine the sufficiency of funds. Annual surpluses are invested in Treasury securities. Annual shortfalls in revenue will be met by redeeming securities held by the NWF or by borrowing from the U.S. Treasury, if necessary.

A cash flow analysis was used. This includes projections of the ongoing kWh fees and projections of when deferred one-time fee payments will be received by the NWF. In addition, this analysis uses the estimated expenditure profile, escalated to YOE dollars, from the 1999 TSLCC analysis (CRWMS M&O 1999b). For each year, the cash flow technique takes the previous year's fund balance, adds the current year revenues, and subtracts the escalated expenditures. This provides an annual analysis of cash flows, in YOE dollars, and annual NWF balances. It also calculates the income from investing the NWF Treasury Bond portfolio, using a forecasted nominal rate of return. This technique also would take into account interest expenses from borrowing for cases where the balance becomes negative, if required. Results are de-escalated to constant 1999 dollars, consistent with the TSLCC (CRWMS M&O 1999b), using the Consumer Price Index (CPI) to eliminate the effects of escalation and the distortions resulting from erosion of purchasing power of distant future dollars.

The investment part of the model starts with the projected coupon and maturity cash flows from the investments held by the NWF on September 30, 1998. At that time the Fund had a market value of $8.6 Billion and a cash balance value, on which the flows are based, of $7.2 Billion. The starting balance of the NWF includes the face value of bills, notes, and bonds, and the purchase price plus amortized discount of zero-coupon bonds. The NWF also properly reflects the net effect of all fees paid, interest earned, and disbursements made to fund historical program costs. The NWF balance provides the starting point for the forward-looking analysis of program cash flows to determine fee adequacy. The difference between the market value and cash balance is a net unamortized premium of $0.5 Billion and unrealized gains in market value of $0.9 Billion. Starting with the cash balance value instead of the market value is immaterial, because all investments are assumed to be held to maturity. Using the projected cash flows adds realism to the model, although some investments will be redistributed based on the cost projections in the 1999 TSLCC (CRWMS M&O 1999b). It is assumed that all future investments are purchased at 100 percent of the face value and are held until maturity.

This cash flow analysis methodology produces the same results as a net present value analysis when the same interest rates are used. The cash flow analysis provides more visibility into how fee revenues, investment income, costs, and the NWF balance vary by year. This methodology

allows cash flow modeling for the current fund portfolio of U.S. Treasury instruments, using the actual investment returns. In addition, this methodology for the 1999 Fee Adequacy Assessment uses a series of interest and inflation rates, during the period of 1998 through 2042, for investment of income and reinvestment of maturing securities, as opposed to applying a single average rate.

The series of interest and inflation rates used in this analysis are extracted from the *Cost Escalation and Interest Rates for 1999* (CRWMS M&O 1999a). The cash flow modeling of investment returns used the 10-year and 1-year Treasury Note series to approximate the investment returns on the matching and contingency portions of the NWF portfolio. The 10-year rate is used for modeling the matching portfolio, as the actual average maturity on this portfolio is closer to 10-years than 30-years, which is the next available rate for which projections are available. Also, the rate differential between the 10-year and 30-year Treasure Notes is small. The 1-year Treasury Note was used for modeling the contingency fund. This rate was chosen as a conservative approximation of the average maturity of the current contingency fund.

3. ASSUMPTIONS

The principal underlying assumptions for this fee adequacy analysis fall into three categories: (1) cost assumptions, (2) revenue assumptions, and (3) economic assumptions. Cost assumptions are based upon the 1999 TSLCC (CRWMS M&O 1999b). Revenue assumptions are based on projections of nuclear power generation. Interest and inflation rate forecasts are documented in the *Cost Escalation and Interest Rates for 1999* (CRWMS M&O 1999a) as part of the economic assumptions. Unless otherwise indicated, all dollar values in the remainder of this report are given in constant 1999 dollars in order to be consistent with the 1999 TSLCC report.

3.1 COST ASSUMPTIONS

The 1999 TSLCC (CRWMS M&O 1999b) estimate provides the cost basis for this assessment. The program costs obtained from the 1999 TSLCC analysis are based on EDA II, described in the LADS Report (CRWMS M&O 1999c), and expanded to cover all wastes planned for geologic disposal. However, this analysis differs from the 1999 TSLCC in categorizing future costs. The 1999 TSLCC includes 1999 costs as part of the program historical costs, and starts future costs in 2000. This analysis includes $0.4 Billion in 1999 costs as future costs to enable the use of the Office of Civilian Radioactive Waste Management FY 1998 audited financial statements (DOE 1999) as the starting point for the NWF balance.

The repository concept costed consists of a one-repository system without interim storage. This concept should be viewed as representative of the system that will ultimately be developed. Program costs will vary from the current estimate if future design approaches differ from the EDA II design in the LADS Report (CRWMS M&O 1999c). Costs may be higher or lower, and the uncertainties will be reduced over time as the Program moves through licensing and implementation. Future generations will make the ultimate decision on whether it is appropriate to continue to maintain the repository in an open, monitored condition or to close the repository. The 1999 TSLCC (CRWMS M&O 1999b) provided two cost estimates, Cases 1 and 2, for similar repository systems that differed only by the length of the monitoring phase. A fee adequacy assessment on these two cases provides insight into financial consequences for deferring the decision to close the repository.

The significant cost changes incorporated into the 1999 TSLCC (CRWMS M&O 1999b) based on EDA II include new waste package designs, titanium drip shields, back fill of the emplacement drifts, and lowering the areal mass loading, which requires excavation into the characterized lower block. The cost estimates for Case 1 and Case 2 have increased from the 1998 TSLCC (DOE 1998a) by $7.7 Billion and $13.0 Billion, respectively. These large increases have decreased the adequacy of the NWF for both cases; however, the adequacy for Case 2 has decreased less than the adequacy for Case 1. This result seems counter-intuitive, as the Case 2 cost increase is close to double the Case 1 cost increase. The reason for this result is that the large cost increases occur primarily at the end of the program when the drip shields and backfill are installed. For Case 1, these costs occur less than 20 years after the end of emplacement. For Case 2, these costs occurs almost 100 years after the end of emplacement, allowing the balance in the NWF to grow large enough to cover these large costs.

Estimated total system life cycle costs, in constant 1999 dollars, are organized into three major categories: (1) Monitored Geologic Repository, (2) Waste Acceptance, Storage and Transportation, and (3) Program Integration and Institutional. Program future costs are estimated to be $44.5 Billion for Case 1 (1999 through 2069), and $49.8 Billion for Case 2 (1999 through 2144). Tables 1 and 2 show the combined government-managed nuclear materials and civilian share allocations of estimated future total system cost for Cases 1 and 2, respectively. The determination of fee adequacy is based only on the civilian share of costs for Case 1 and Case 2.

Table 1. Case 1 Summary of Allocations of TSLCC Future Costs (Millions of 1999$)

Category	Future Cost Allocation – Case 1[a] (1999-2069)		
	Government-Managed Nuclear Material	Civilian	Total
Monitored Geologic Repository	9,510	23,090	32,600
Waste Acceptance, Storage and Transportation (including Nevada Transportation)	1,490	4,890	6,380
Program Integration and Institutional	1,580	3,920	5,500
Total[b]	**12,580**	**31,900**	**44,480**
Aggregate Allocation Percent[c]	28.3 percent	71.7 percent	100 percent

NOTES: [a] These future cost allocations differ from the 1999 TSLCC (CRWMS M&O 1999b) since estimated 1999 costs are included for forward-looking analysis.
[b] Totals may not add due to independent rounding.
[c] Percentages are based on allocating total system life cycle costs.

Table 2. Case 2 Summary of Allocations of TSLCC Future Costs (Millions of 1999$)

Category	Future Cost Allocation – Case 2[a] (1999-2144)		
	Government-Managed Nuclear Material	Civilian	Total
Monitored Geologic Repository	10,970	26,090	37,060
Waste Acceptance, Storage and Transportation (including Nevada Transportation)	1,500	4,890	6,390
Program Integration and Institutional	1,840	4,500	6,340
Total[b]	**14,310**	**35,480**	**49,790**
Aggregate Allocation Percent[c]	28.7 percent	71.3 percent	100 percent

NOTES: [a] These future cost allocations differ from the 1999 TSLCC (CRWMS M&O 1999b) since estimated 1999 costs are included for forward-looking analysis.
[b] Totals may not add due to independent rounding.
[c] Percentages are based on allocating total system life cycle costs.

3.1.1 Design Alternative

The LADS Report (CRWMS M&O 1999c) evaluated five design alternatives. The EDA II was selected and forms the basis for the 1999 TSLCC (CRWMS M&O 1999b) estimates. EDA I was the highest cost alternative and, as such, provides a reasonable upper bound for potential cost

increases. Changing to the EDA I design would increase costs since the emplacement area would need to be expanded into uncharacterized areas, and the quantity of waste packages would increase. The LADS Report estimates a 23 percent repository cost increase from changing to the EDA I design from the EDA II design for a 70,000 MTHM system (CRWMS M&O 1999c). Based on total system costs which include extrapolating the EDA I design to accommodate all the waste, and factoring in the remainder of the program costs such as transportation, which would be unchanged, leads to a program cost increase of approximately 20 percent.

3.1.2 Reduction in Cost Uncertainty

Cost uncertainties will be reduced as the program progresses from licensing to construction and finally to waste emplacement. Scope uncertainties will be eliminated as design issues are closed during licensing and major decisions are finalized. Summarized below are major decisions that will affect program scope, which drives system costs, and a schedule for their anticipated resolution:

- Site Recommendation – determines suitability of Yucca Mountain..... 2001
- License Application – narrows design alternatives..... 2002
- Nevada rail transportation route selection – narrows route choices from five to one.....2002-2004
- Construction Authorization – defines additional requirements from NRC review..... 2005
- Determination of need for a second repository.....2007-2010
- Decision to close the repository.....2060-2135
- Repository closed for Case 1..... 2069
- Repository closed for Case 2..... 2144

3.2 REVENUE ASSUMPTIONS

The 1.0 mill per kWh fee revenue used in this analysis was derived from data on the Nuclear Fuel Data Form RW-859 (CRWMS M&O 1996). This data was collected from the utilities for historical discharges and a forecast of future discharges, calculated by extending utility projections to end of reactor life (CRWMS M&O 1998). It is assumed in this projection that commercial units will operate for 40 years from the issuance of their operating licenses without extensions, and reactor performance will not be affected by aging. RW-859 SNF projections and the resulting fee projections have been adjusted for cancellation of three planned nuclear power units (Bellefonte 1 and 2, and Watts Bar 2), and early shutdowns of Zion 1 and 2, Big Rock Point, Maine Yankee, and Haddam Neck. The cumulative discharge of civilian SNF is estimated to be approximately 86,000 metric tons of heavy metal. The actual and predicted burnup of this

discharged fuel was used to obtain an estimate of electrical output, which was multiplied by the fee to obtain the fee revenue, after taking into account plant efficiencies.

This evaluation incorporates the revenue losses resulting from an amendment to the Standard Contract for Disposal. The amendment was required by two District of Columbia Circuit Court decisions: one in 1985 and one in 1989 (Wisconsin Electric Power Co. v. U.S. Department of Energy, 778 F. 2d 1; Consolidated Edison v. U.S. Department of Energy, 870 F. 2d 694). These decisions determined that ongoing nuclear utility fees should be based on electricity generated and sold. In FY 1995, the Department made its final reimbursement to the utilities as a result of this revision to fees collected through FY 1990. For this analysis, the Department assumed a 6 percent reduction in future net generation to account for transmission and distribution losses.

It is assumed that funds paid by the Department for the disposal of DOE SNF and HLW will be sufficient to cover its full cost share and accrued interest. Any outstanding balances for prior year shares will be paid prior to initial waste acceptance. Annual budget request levels for the disposal of DOE SNF and HLW will be developed according to the Department's memoranda of agreement (DOE 1998c, DOE 1998d) and subject to Congressional appropriations. After initial waste acceptance, it is assumed that the Defense Nuclear Waste Disposal appropriations match the annual share for government-managed material.

Table 3 presents the amount of assumed annual appropriations for government-managed nuclear materials through 2015. For this analysis, it is assumed, based on the OCRWM budget planning, that an annual appropriation of $200 Million YOE dollars for Defense Nuclear Waste Disposal is constant from 2002 through 2004. From 2005 through 2009, it is assumed that the annual appropriation is increased to $630 Million YOE dollars for Case 1, and $650 Million for Case 2. A final appropriation of $620 Million for Case 1 and Case 2 would be required in 2010. This level of appropriation would reduce the prior outstanding financial obligation for government-managed nuclear materials to $0 by the start of waste acceptance. Assumed annual defense amounts are included in this analysis since defense appropriations offset expenditures from the Fund.

This analysis calculated the outstanding balance, owed for government-managed nuclear materials, to be $1.5 Billion at the end of FY 1998. The 1999 TSLCC (CRWMS M&O 1999b) recalculated the civilian and government shares based on the updated estimate of total program costs, from inception through closure and decommissioning. Changes to prior year cost shares resulted in an increase in the outstanding obligation for government-managed materials. This analysis assumes repayment of the obligation, as described above, to allow analysis of the adequacy of the fees paid for commercial SNF to fund the civilian share of program costs. The calculation of the outstanding obligation for government-managed materials takes into account both the annual share of prior year costs, and the interest accrued on outstanding obligations. The annual share factor is determined using constant dollars and by applying the methodology published in the Federal Register and described in the 1999 TSLCC (CRWMS M&O 1999b).

Table 3. Assumed Annual Appropriation for Government-Managed Nuclear Materials (Millions of YOE Dollars)

Fiscal Year	Assumed Annual Appropriations for Government-Managed Nuclear Materials	
	Case 1	Case 2
1999	189	189
2000	112	112
2001	112	112
2002	200	200
2003	200	200
2004	200	200
2005	630	650
2006	630	650
2007	630	650
2008	630	650
2009	630	650
2010	620	620
2011	240	250
2012	290	290
2013	340	350
2014	350	350
2015	410	410

Note: Actual payment schedules will be developed in accordance with the Department's memoranda of agreement and subject to Congressional appropriations.

If the disposal fee remains unchanged at 1.0 mill per kWh of electricity generated and sold, the cumulative fee revenues will be equivalent to $24.6 Billion in 1999 dollars. The cumulative fees are comprised of annual disposal fees, one-time fees, and interest accrued on deferred one-time fees. Fee projections for 1999 through 2009 are based on discharge data provided by the Energy Information Administration in an interoffice correspondence from the Director, Coal, Nuclear and Renewable Division to the Director, Waste Acceptance and Transportation Division, September 16, 1999 (Geidl, J. 1999). Annual disposal fee payments total $19.3 Billion (in 1999 dollars) from FY 1983 to FY 2036 ($10.2 Billion for FY 1999 through FY 2036) under the no-new-orders scenario.

The standard contracts for disposal between the Department and utilities provided two deferred payment options for one-time fees. Deferred fees can be paid either as 40 quarterly payments in the 10 years prior to acceptance of fuel, or as a lump sum payment prior to waste acceptance. At the end of FY 1998, $0.9 Billion of principal currently remained deferred and will continue to accrue interest at the 13-week Treasury bill rate. For this analysis, it was assumed that lump-sum payments of deferred one-time fees are to begin in 2010, and coincide with the first pick-up of SNF from a utility with an outstanding balance.

In addition to the fees and interest on deferred one-time payments discussed above, the interest on unexpended NWF balances provides revenue. NWF balances are invested by the Secretary of the Treasury in obligations of the United States with maturities appropriate to the needs of the program. The analysis below addresses the sensitivity of the fee adequacy assessment to future combinations of nominal interest rates and inflation.

3.3 ECONOMIC ASSUMPTIONS

Economic assumptions used in this fee adequacy report consist of inflation and interest rate forecasts, and an assumed investment strategy.

3.3.1 Projected Inflation and Interest Rates

The interest and inflation rates used in this analysis are extracted from the *Cost Escalation and Interest Rates for 1999* (CRWMS M&O 1999a), and are shown in Figure 4.

- Consumer Price Index - All Urban Consumers – This forecast provides the discount rate used to convert YOE fees and income to current year dollars.

- 10-Year and 1-Year Treasury Note Series – The 10-year rate forecast provides the annual nominal interest rate earned on future investment portfolio holdings, excluding current investments. The 1-year note rate forecast provides the annual nominal interest rate earned on the contingency portion of the fund. For purposes of simulating the investment strategy, current investments, held as of September 30, 1998, are assumed to be held until maturity and earn their actual coupon return until maturity.

- 13-Week Treasury Series – This forecast provides the rate used in the calculation of the interest portion of the deferred one-time fees and outstanding balance on government-managed nuclear materials.

3.3.2 Investment Strategy

This analysis simulates the expected results of the program's investment strategy. The objectives of the strategy are to: (1) ensure that investment income is available when needed; (2) support the adequacy of the fee paid into the NWF by waste owners and generators; and (3) hedge against uncertainty and unplanned funding requirements. To achieve these objectives, the NWF is managed as two portfolios: a contingency portfolio and a match portfolio. The purpose of the contingency portfolio is to hedge against reasonable contingencies such as unexpected near-term expenditures. The purpose of the match portfolio is to provide reliable funding for expected program expenditures. It serves to bring into balance the program's assets and liabilities and to maintain that balance. The contingency portfolio is highly liquid and consists of Treasury securities whose average maturity is approximately 3 years. The match portfolio consists of a mix of Treasury bills, notes, bonds, and zero-coupon bonds. The durations and present values are matched or will be matched, year-for-year, to the durations and present values of the program's projected liabilities. Matching investments to planned spending reduces the sensitivity of the fee adequacy balance to changing interest rates. Each month, near-term cash flow expectations and current asset and liability values are re-assessed and used as the basis for

investment selection. The portfolio is rebalanced, as required, upon completion of each new total system life cycle cost analysis or when changes in program assumptions warrant.

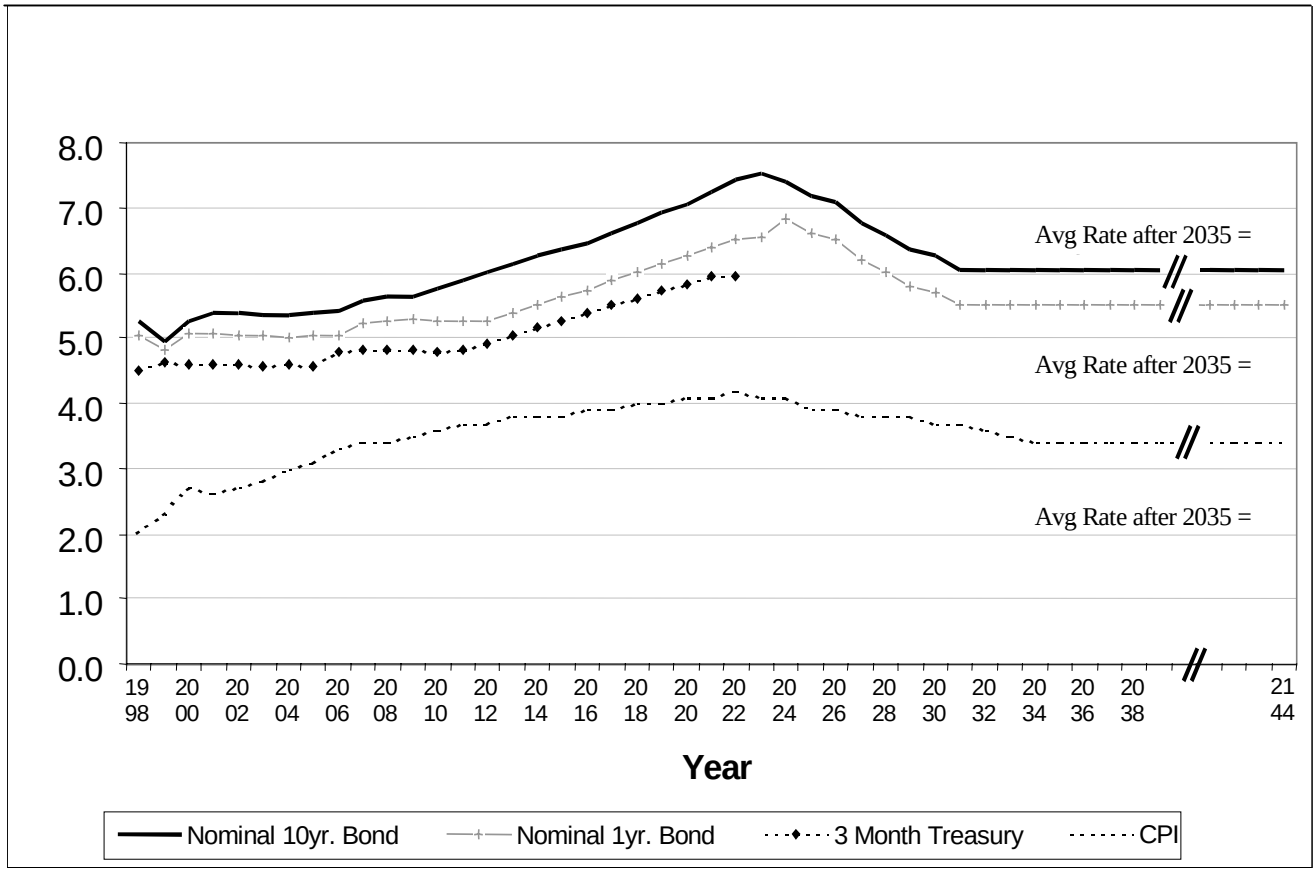

Figure 4. Inflation and Interest Rates Used for Calculating Fee Adequacy

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4. FEE ADEQUACY

This analysis finds that the current 1.0 mill per kWh fee charged on generators of commercial SNF is adequate, and recommends that the fee remain unchanged. This recommendation is based on the examination and analysis of revenue forecasts and estimated costs for Cases 1 and 2 as described in the 1999 TSLCC estimate (CRWMS M&O 1999b). The NWF is projected to have a positive balance at the end of waste emplacement activities based on current program cost estimates, fee revenue projections, and independent projections of inflation and interest rates. This balance is expected to be sufficient to fund the planned program and to allow for contingencies. Ending the emplacement period with sufficient capital in the NWF will retain alternatives for future decision-makers. A NWF balance in excess of the minimum requirement provides a margin of safety for uncertainties or changes in program scope, costs, revenues, and economic assumptions.

This current assessment is based on economic assumptions that have changed significantly from the previous assessment (DOE 1998a). The real interest rate on the 10-year Treasury note used in this analysis is 3.0 percent, which is significantly higher than the 45-year historical average of 2.5 percent. Projected balances in the NWF are highly sensitive to the economy's real rate of return, approximated by the difference between the nominal interest rate and the inflation rate.

This analysis finds that even if current program cost estimates are evaluated utilizing the more conservative 1998 economic assumptions (Standard and Poor's DRI 1998), then the fee is adequate, but less so than for the Viability Assessment reference system (DOE 1998a). The changes for Case 2 have a negligible effect on adequacy because closure and decommissioning costs in distant outyears are discounted for many years. The fee is also adequate for Case 1, 50-year closure, but with less margin than in the 1998 fee adequacy analysis (DOE 1998e).

4.1 FEE ADEQUACY RESULT

This analysis finds the current 1 mill per kWh fee is adequate for the updated 1999 TSLCC (CRWMS M&O 1999b) estimate for both Cases 1 and 2. Results of this analysis for Cases 1 and 2 are presented in Figures 5 and 6. The black lines on Figures 5 and 6 represent the boundary between the Fee Adequate/Fee Not Adequate areas, for Cases 1 and 2 of Scenario 1 in Table 4, with current costs and economic assumptions. Points along the lines reflect different combinations of a percentage change in the annual inflation rate and a corresponding percentage change in the annual nominal interest rate. This results in a NWF balance equaling, in constant 1999 dollars, a target value in 2042 after the completion of waste emplacement. The target values in 2042 are $5.3 billion for Case 1 and $3.9 billion for Case 2.

The $5.3 Billion and $3.9 Billion target balances in 2042 for Cases 1 and 2 were calculated as the net present value of future costs needed to cover the monitoring, closure, and decommissioning activities in 1999 constant dollars. The discount rate for the net present value calculation for estimating the capital required in 2042 was the average nominal interest rate for the period 2043 to 2069 for Case 1 and 2043 to 2144 for Case 2, decreased by 25 percent for economic uncertainty.

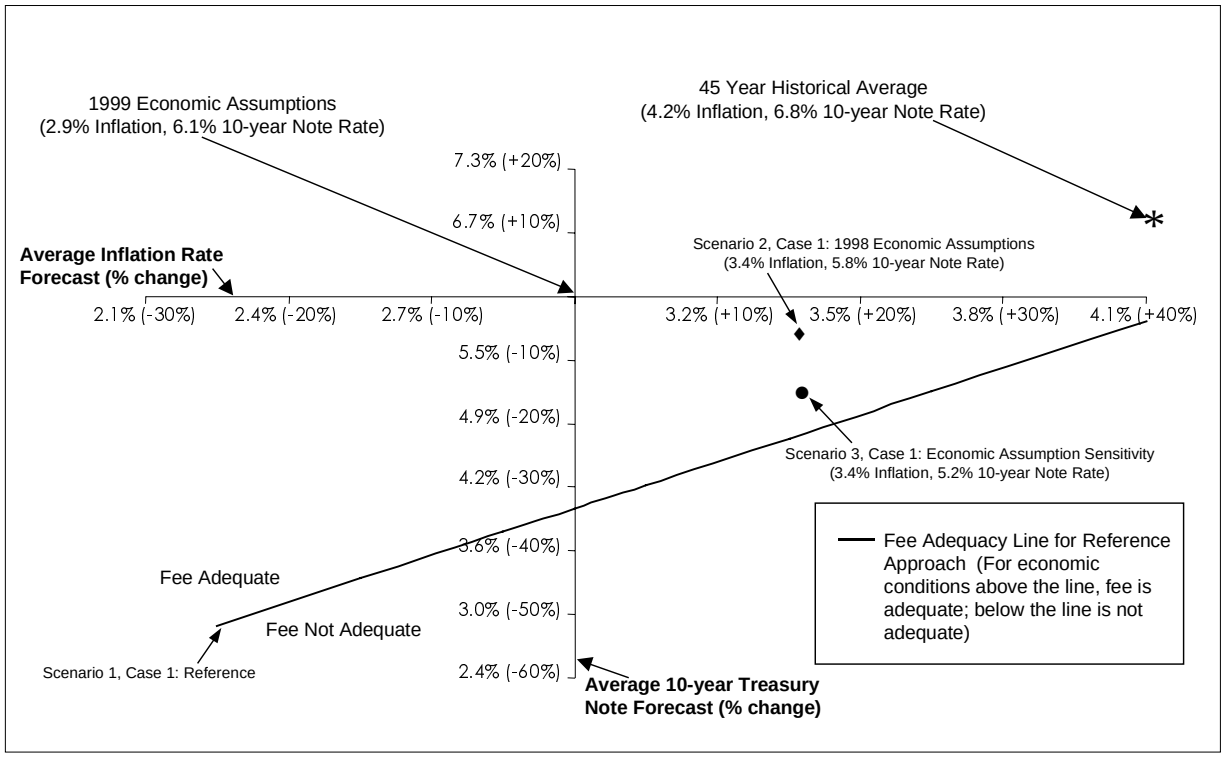

Figure 5. Case 1 Fee Adequacy: Sensitivity to Changes in Economic Assumptions with Current Program Costs

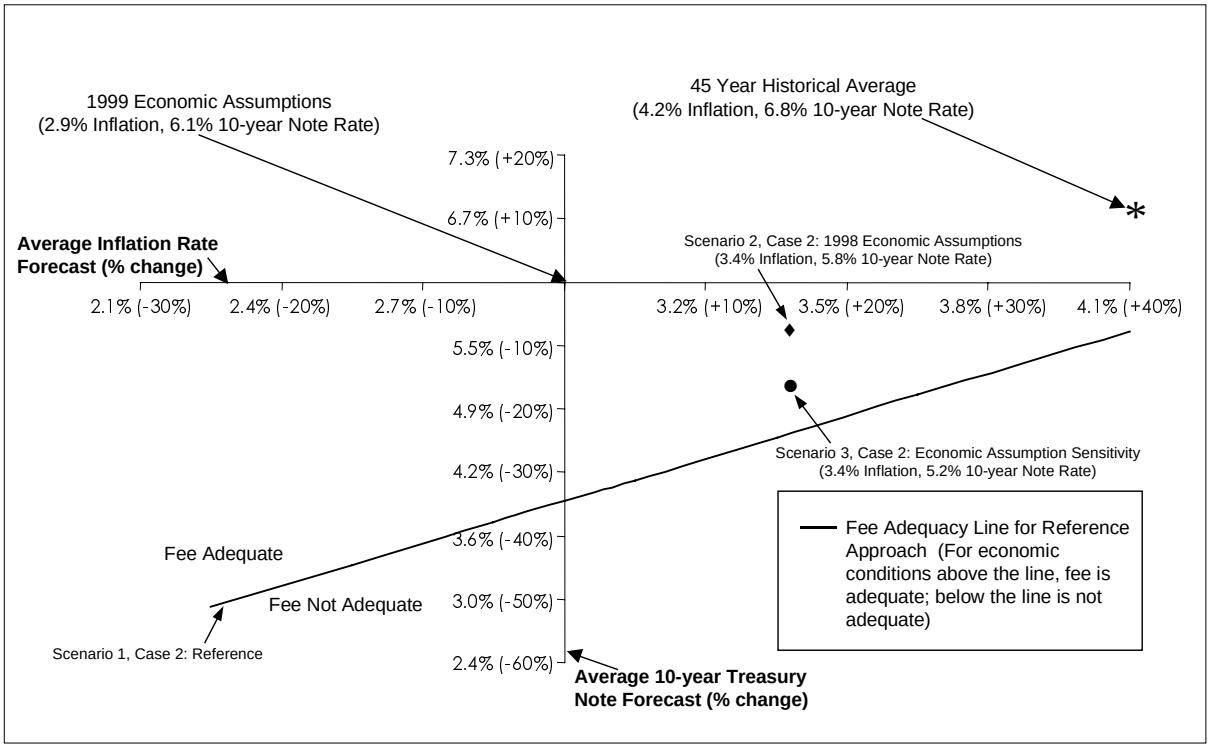

Figure 6. Case 2 Fee Adequacy: Sensitivity to Changes in Economic Assumptions with Current Program Costs

Table 4. Sensitivity Analysis on NWF Adequacy for Alternative Economic and Cost Scenarios

Scenario	Case 1		Case 2	
	NWF Balance in 2042	NWF Adequacy (Target = $5.3 Billion)	NWF Balance in 2042	NWF Adequacy (Target = $3.9 Billion)
1. 1999 TSLCC Reference Cost (Avg. Nominal Interest Rate = 6.1 percent, Avg. Inflation Rate = 2.9 percent)	$23.3 Billion	Adequate	$23.7 Billion	Adequate
2. 1999 TSLCC, using 1998 Rates (Avg. Nominal Interest Rate = 5.8 percent, Avg. Inflation Rate = 3.4 percent)	$12.7 Billion	Adequate	$13.0 Billion	Adequate
3. 1999 TSLCC Reference Cost with a 15 percent decrease in Nominal Interest Rate and 15 percent increase in Inflation Rate (Avg. Nominal Interest Rate = 5.2 percent, Avg. Inflation Rate = 3.4 percent)	$8.3 Billion	Adequate	$8.2 Billion	Adequate
4. 1999 TSLCC Reference Cost with a 20 percent Cost increase (Avg. Nominal Interest Rate = 6.1 percent, Avg. Inflation Rate = 2.9 percent)	$14.8 Billion	Adequate	$15.2 Billion	Adequate
5. 1999 TSLCC, using 1998 Rates and a 20 percent Cost increase (Avg. Nominal Interest Rate = 5.8 percent, Avg. Inflation Rate = 3.4 percent)	$5.5 Billion	Adequate	$5.8 Billion	Adequate

The slope of the lines represents the percentage increase in the inflation rate for a percent change in the 10-year Treasury note rate that keeps the program on the fee adequacy boundary. If the intersection point of the axes of percentage changes in the forecasted 10-year Treasury note rate and the CPI inflation rate falls below the line, the balance of the NWF after emplacement is too small to fund remaining projected costs. The zero intercept (center point) represents the current interest and inflation forecasts (CRWMS M&O 1999a). The asterisk in Figures 5 and 6 provides the 45-year historical average of inflation and the 10-year Treasury note rate.

4.2 FEE ADEQUACY SENSITIVITY

Fee adequacy is sensitive to changes in costs and economic assumptions. Table 4 compares the fee adequacy results of Scenario 1 with four scenarios to address the sensitivity to changes in economic assumptions and costs. Scenario 1, represented by the diagonal lines in Figures 5 and 6, is the reference system estimated for Cases 1 and 2 in the 1999 TSLCC (CRWMS M&O 1999b).

Scenario 2, depicted as a single point in Figures 5 and 6, shows the effect of the change in forecasted nominal interest and inflation rates. Between the last Fee Adequacy assessment (DOE 1998e) and this assessment, the real forecasted interest rate on 10-year Treasury notes has increased by approximately a half a percent, which is a large increase for an annual update. The real interest rate on the 10-year Treasury note used for Scenario 2 was 2.3 percent (Figure 3).

Scenario 3, depicted by a single point in Figures 5 and 6, illustrates the sensitivity of the NWF balance to changes in assumed interest and inflation rates. If the forecasted CPI inflation rate increased 15 percent and the forecasted 10-year Treasury note rate decreased 15 percent, the result would be a smaller NWF balance in 2042. The Scenario 3 NWF Balances in 2042 are 35 percent of the Scenario 1 balances for Cases 1 and 2. Under these conditions, the fee would be adequate.

Scenario 4 is represented in Figures 7 and 8 by the black lines to show the sensitivity of fee adequacy to an across-the-board 20 percent increase in estimated costs. The fee adequacy line in Figures 7 and 8 illustrates that under the current inflation forecast, the program is fee adequate with a 20 percent increase in future costs.

Scenario 5 combines the sensitivities of Scenarios 2 and 4 by using the 1998 interest and inflation rates with a 20 percent across-the-board cost increase. The results of Scenario 5, depicted as a single point in Figures 7 and 8, show that for Case 1 the fee is marginally adequate, and for Case 2 the fee is adequate. The margin for Case 1 is $0.2 Billion, and the margin for Case 2 is $1.9 Billion over the target NWF balances in 2042. In Figure 7, the Scenario 5 point is just above the diagonal line and is barely in the "fee adequate" region. In Figure 8, the Scenario 5 point is above the diagonal line and in the fee adequate region.

4.3 ANNUAL DATA

Table 5 provides a detailed breakout of forecasts of the 1.0 mill per kWh fee, one-time fee payments, and income from investments in the NWF for Case 1 and Case 2, using the current interest and inflation rates forecasts (CRWMS M&O 1999a). Table 5 is presented in YOE dollars, as these categories are used to assist the budget formulation process.

Table 6 provides an annual flow of the civilian cost share in constant 1999 dollars for Case 1 and Case 2. Since Tables 5 and 6 are in different units of measurement, comparisons are not appropriate. The civilian cost share is less than the calculated annual shares, prior to 2010, due to assumed repayment of prior outstanding government financial obligations, including interest, for government-managed nuclear materials. The repayment of outstanding balances offsets the civilian cost share in the early years since this receipt of funds, greater than the annual cost share, reduces the need to withdraw funds from the NWF. For a given year, the current Fund balance equals the previous year's Fund balance plus fee payments, one-time fee payments, and income from investments less the civilian cost share. However, using the data from Table 5 and Table 6, the NWF balance can not be calculated, since these tables are in different cost units.

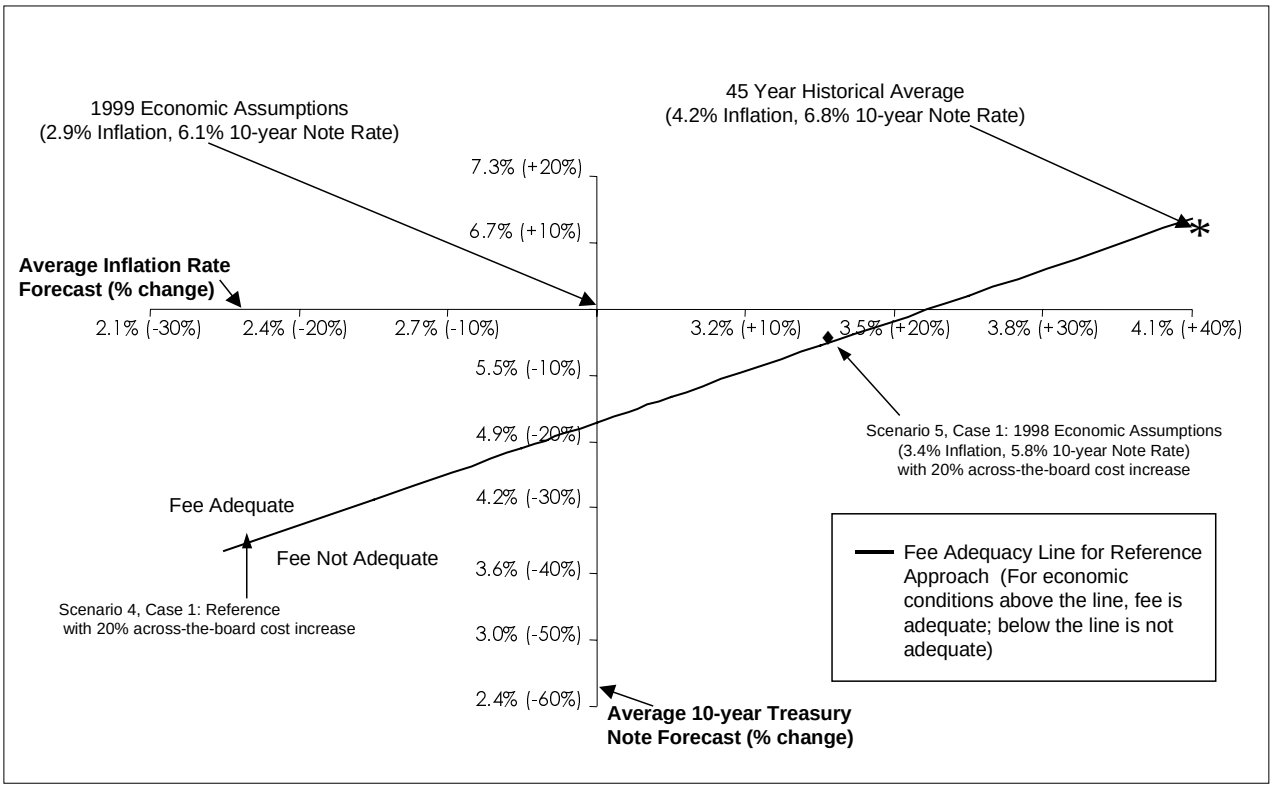

Figure 7. Case 1 Fee Adequacy: Sensitivity to Changes in Economic Assumptions for a 20 Percent Increase in Program Costs

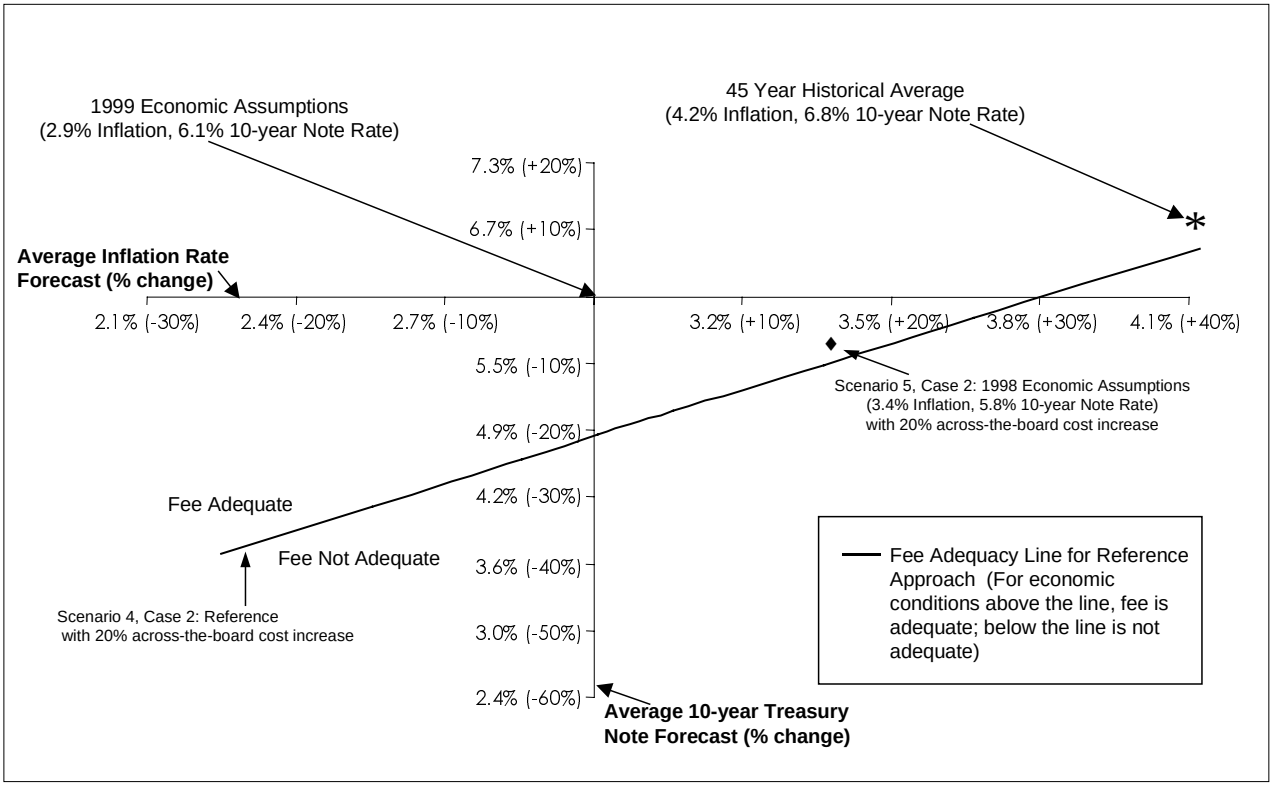

Figure 8. Case 2 Fee Adequacy: Sensitivity to Changes in Economic Assumptions for a 20 Percent Increase in Program Costs

Table 5. Detailed Nuclear Waste Fund Fee and Income Flows for Case 1 and Case 2 (Millions of YOE $)

Fiscal Year	Fee Payments	One-Time Fee Payments	Income from Investing Case 1	Income from Investing Case 2
1999	660	0	590	590
2000	660	0	670	670
2001	660	0	700	700
2002	650	0	730	730
2003	650	0	770	770
2004	650	0	820	820
2005	650	0	860	860
2006	650	0	900	900
2007	640	0	940	950
2008	640	0	990	990
2009	640	0	1,030	1,030
2010	610	2,320	1,100	1,110
2011	590	610	1,320	1,320
2012	560	0	1,420	1,430
2013	520	910	1,530	1,540
2014	460	0	1,670	1,680
2015	410	50	1,770	1,790
2016	390	0	1,880	1,890
2017	360	0	2,000	2,010
2018	350	0	2,130	2,150
2019	350	0	2,270	2,290
2020	350	0	2,460	2,480
2021	330	0	2,640	2,660
2022	310	0	2,840	2,860
2023	260	0	3,020	3,040
2024	210	0	3,150	3,170
2025	150	670	3,270	3,300
2026	110	0	3,420	3,450
2027	60	0	3,400	3,440
2028	40	0	3,440	3,480
2029	30	0	3,460	3,500
2030	20	0	3,520	3,560
2031	10	0	3,510	3,550
2032	10	0	3,630	3,670
2033	10	0	3,740	3,780
2034	0	0	3,850	3,900
2035	0	0	3,960	4,010
2036	0	0	4,080	4,140
2037	0	0	4,210	4,270
2038	0	0	4,340	4,400
2039	0	0	4,480	4,550
2040	0	0	4,640	4,710
2041	0	0	4,840	4,910
2042	0	0	5,070	5,150
Total[a] (99-42)	**13,700**	**4,600**	**111,100**	**112,200**

NOTES: [a]Totals may not add due to independent rounding. Fee revenues continue until 2036 (for 2030 through 2036 the fee is less than $5M/yr and rounds to zero).

Table 6. Detailed Nuclear Waste Fund Cost Share for Case 1 and Case 2 (Millions of 1999$)

Fiscal Year	Civilian Cost Share Case 1	Civilian Cost Share Case 2
1999	180	180
2000	260	260
2001	330	330
2002	220	220
2003	250	250
2004	260	260
2005	360	340
2006	610	600
2007	500	490
2008	450	430
2009	150	140
2010	260	260
2011	520	520
2012	600	600
2013	670	670
2014	660	660
2015	730	730
2016	740	740
2017	620	610
2018	610	610
2019	570	570
2020	570	570
2021	590	590
2022	560	560
2023	560	560
2024	570	560
2025	630	620
2026	630	620
2027	610	600
2028	610	600
2029	640	630
2030	660	650
2031	620	620
2032	650	650
2033	680	670
2034	690	690
2035	650	650
2036	640	640
2037	640	630
2038	580	580
2039	580	570
2040	490	490
2041	260	260
2042	140	140
Civilian Costs from 1999-2042	**22,800**	**22,600**
Civilian Cost after 2042	**7,230**	**10,900**
Total	**30,030**	**33,500**

4.4 FEE ADEQUACY ANALYSIS CONCLUSION

This assessment concludes that the 1.0 mill per kWh fee is sufficient at this time for Cases 1 and 2. However, future economic conditions may vary from the forecasts used in this analysis, and costs may vary due to future changes in program scope. This analysis used forecasted (CRMWS M&O 1999a) real interest rates that remained above the historical average for the entire analysis period. In the future the real interest rate forecast may decline toward its historical average.

5. REFERENCES

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5.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

52 FR (Federal Register) 31508. Energy: Civilian Radioactive Waste Management; Calculating Nuclear Waste Fund Disposal Fees for Department of Energy Defense Program Waste. Readily available.

Nuclear Waste Policy Act of 1982. 42 U.S.C. 10101 et seq. Readily available.